

Robert Craig Group

EXPERIENCE IN TEACHING AND OUTREACH

I enjoy teaching. In fact, the challenges and joys involved in efficiently exposing students to powerful knowledge are exactly what brought me here to the University of Virginia.

My father was an English professor at a small college campus in South Carolina. As a result, I have always valued teaching as one of the most noble professions. Through my teaching responsibilities over the last 15 years at four different college campuses I have had the chance to lecture on multiple topics of physics. In addition, as a student I developed my teaching skills through many years of private tutoring. Most recently, several focused teaching workshop have allowed me to continue to evolve my teaching techniques towards pedagogy proven effective by recent research.

The importance of excellence in teaching is overlooked far too often. I have made significant contributions to my research field over the course of my career; however, I hope that these will pale in comparison to the accomplishments of the students that I influence and the people I introduce to our field through outreach efforts. As a researcher, I know that my direct contributions are limited by my lifespan, but if I can pass along my interest in the topic, and my will to help a student discover the excitement of science, then I know my contributions to physics and to society will be far greater.

I am an experimental particle physicist. The goal of this field is to provide a complete description of how the universe was created and the how the fundamental laws that govern its evolution behave. In order to study these elementary particles and forces, my colleagues and I use particle accelerators to collide particles in a controlled environment and study the results of the collisions. Due to the prohibitive cost of these large machines this research can only be carried out at a few locations in the world. In the US, Fermilab, located 50 miles west of Chicago, is the only facility. Prior to coming to UVA I was a post-doctoral researcher at Fermilab. My work there was successful and I was presented with several choices for tenure-track employment including the Wilson Fellowship at Fermilab. The Wilson Fellowship would have paid more, been located at the premier US facility, and kept me with no teaching requirements – a dream position for a scientist. I chose UVA primarily because my dream had always been to be a professor, not just a scientist. So, the opportunity to teach and to work with students is one of the primary factors that brought me here to UVA.

I strive to be an excellent teacher, not a professor focused solely on research. During my first semester here I taught PHYS 2020, an introductory class of 200 pre-medical students. I survived that first semester, but it was challenging in ways that I didn't expect. That summer I attended the New Physics and Astronomy Faculty Teaching Workshop which is held annually by the American Association of Physics Teachers. The workshop is an intense three-day introduction to pedagogy that has been proven to be effective in teaching physics. The experience opened my eyes to new techniques and to a large body of research supporting the value of incorporating strategies that deviate from the classical lecture. When I taught PHYS 2020 again the next year I improved the class by incorporating several techniques

that I learned from the workshop. For example, I made the in-class response system a larger component of the lecture. When it was clear from the response system that a concept was not understood by the class, I encouraged discussion and allowed a few minutes for students to “convince their neighbor” before polling the class again. The response system combined with the follow-up peer instruction seemed to improve the effectiveness of our lecture time. Another related technique was to include a pre-class quiz before every lecture to encourage students to read the text. I promised them that I would not cover everything in the book, that as college students reading was their responsibility, and that I would use the extra class time for more interactive purposes. I assured them that these techniques were proven to improve their learning. I think that overall the class accepted this strategy, read more in advance of class, and learned more during our lecture periods.

I use many physics demonstrations in class. While teaching PHYS 2020 I realized that I was truly enjoying the process of setting up and learning how to use each of the demonstrations and presenting them to the class. I thought students might like this too, so I presented it as a “Dream Idea” to the Mead Endowment. With the award I hosted a series of meetings with Physics majors in which we investigated demonstrations that were available, and even purchased some new ones for the Physics Department. Two undergraduate students presented some of our demos at the annual “Physics Day” event in front of about 200 middle school students. Another student involved in the program went on to participate in an independent study in which he built a cosmic ray detector that could be used as a physics demonstration in Modern Physics courses.

I enjoyed teaching the large general physics class for pre-med students, but I had the opportunity to transition to PHYS 1610. PHYS 1610 is the first-semester introductory physics class for students who might want to major in physics. There are about 50 first-year students in the class but only about half of them will actually go on to a degree in physics. A major challenge in this course is to present it in such a way that challenges even the brightest physics majors while making it a fair introductory test for the students who realize early in the semester that majoring in Physics might not be for them. Surprisingly, I find that helping students figure out that Physics might not be their best option is a very rewarding part of teaching the course. College is short; it is best to start pointing in the right direction as soon as possible.

In addition to my teaching, I have undertaken several efforts to mentor students and enhance the undergraduate atmosphere in the Physics department. The Mead program above is one example and I have also served as the faculty advisor the the Society of Physics Students and the physics honor society, Sigma Pi Sigma. Finally, in my second year here I used a grant from the Jefferson Trust to start an undergraduate research program called the Particle Physics Research Adventure in which UVA physics majors compete to spend a summer at Fermilab. This is a year-long program in which students apply to the program in the winter, begin their work in the spring, spend the summer at Fermilab working full time on their projects, and then give a talk at a regional conference in the fall semester. Typically, two students have been selected each year. The program has become highly competitive, and the students have successfully contributed to experiments at Fermilab. I’m proud of this program, and it has been a joy to mentor students and witness their first research experiences.

In my opinion, the most important thing that scientists can do as role models is to donate some of their time to another interested mind. Often, this effort results in a greater understanding for both parties! In my short career, I have taken advantage of many opportunities to stimulate interest in physics research in the classroom and through outreach activities. For the pre-med students of PHYS 2020 I always took the last lecture to show them how the physics they learned in class could help them understand my research. I also invited them to the Hoxton public lecture that is held every spring stating that “this was the closest they would probably ever be to being a physicist, so they should attend and maybe even enjoy the lecture”. I always invite the potential Physics majors in PHYS 1610 to the meetings of the Society of Physics Students and encourage them to “Think like a scientist!”. For the last few years I’ve instigated the policy of taking three or four top performers to lunch at the Garden Room after every exam. My classes have been rather large, and this gives me a chance to get to know some of the top students in the class in addition to the ones that are struggling and that I meet through repeated visits at my office hours. In office hours or outside of class I’m always thrilled when a student asks about my research.

In summary, I’m here at UVA because I want to teach and I have put every effort that I can afford into doing it well. I work hard to have a positive impact in the classroom and to serve as a mentor to students. I rank my success as a teacher among my highest accomplishments and I look forward to the opportunity to teach students of physics at every level and to improve my technique for years to come.

For completeness, I include a list of my past teaching and outreach experience on the following pages.

TEACHING EXPERIENCE AT UVA

PHYS 1010

Spring 2016 and 2017

The Physical Universe I, I redesigned this physics course for non-science majors.

PHYS 1710

Fall 2016 and 2017

I redesigned this first-semester physics major course.

Nucleus Program, UVA

2015

Nucleus is a program designed to help faculty improve STEM education at UVA using research-based pedagogies and assessment.

Course Design Institute, UVA

Summer 2015

CDI is an intensive, multi-day, hands-on seminar. I am applying these learning-focused course design ideas to the redesign of PHYS 1710.

PHYS 1610

Fall 2013 and 2014

Lectured and managed this course for approximately 50 first-year Physics majors per year. The course covered the topics of classical mechanics and special relativity.

PHYS 2020

Spring 2011, 2012, and 2013

Lectured and managed this course for approximately 200 pre-med students per year. The course covered the topics of electricity and magnetism, geometrical optics, and modern physics.

PHYS 3993

Spring 2013

I have had one student do independent study with me who registered for PHYS 3993:

– Elton Ho (Spring 2013)

PHYS 3995

2011 – 2014

I have had 14 undergraduate students do research with me and register for PHYS3995:

– Tyler Lam and Nina Mazzairelli (Fall 2016) – Hannah Kessenich (Fall 2015) – Rob Mina, Eric Fries, and Yongyi Wu (Fall 2014)

– Ranjani Sarma and Liting Xiao (Fall 2013)

– David Wilson and Alyssa Henderson (Fall 2012)

– Kaitlin Johnson, David Abbott, and Jeff Lansford (Spring 2011)

– Eric Nguyen (Spring 2011)

Teaching Workshop

Summer 2011

College Park, MD

Attended three-day new physics and astronomy faculty teaching workshop held by American Association of Physics Teachers.

TEACHING EXPERIENCE PRIOR TO UVA

Teaching Assistant

2003 – 2004

Department of Physics, University of Florida

Led discussion sections, held office hours, and graded exams for introductory physics II.

Teaching Assistant

1999 – 2000

Department of Physics, Florida State University

Taught lab sessions, held office hours, and graded lab reports for introductory Astronomy class.

Private Tutor

2000 – 2005

Department of Physics, University of Florida

Department of Physics, Florida State University

Teaching Assistant

1998 – 1999

Erskine College

Assisted students in setup and performance of modern physics lab.

POLITICAL OUTREACH EXPERIENCE

- Tour of UVA HEP lab for Representative Robert Hurt (April 2014)
- DC trip to advocate for support of particle physics (2013, 2014, 2015, and 2016)
- Government Relations Committee, Fermilab Users’ Executive Committee (Organizer for 2013 and 2014 DC trip to advocate for support of particle physics.)
- Lunch with Steve Koonin, DOE Under Secretary for Science (Fermilab Users’ meeting 2010)
- Lunch with Daniel Poneman, DOE Deputy Secretary and William Brinkman, DOE director of the Office of Science

GENERAL OUTREACH EXPERIENCE

Organized Public Lecture:

Using funds from a Page-Barbour grant I obtained, I organized a public lecture from nobel laureate Adam Riess. More than 450 people attended his lecture “The Accelerating Universe” at the Jefferson Theater in downtown Charlottesville. Fall 2016.

Boy Scouts - nuclear physics merit badge:

Particle and nuclear physics overview and tour of UVA HEP lab. Fall 2014.

Q&A Session for the documentary film *Particle Fever*:

Downtown Mall Regal Cinema in Charlottesville, Spring 2014.

UVA College Science Scholars:

Particle physics overview and tour of UVA HEP lab. Fall 2013, 2014, 2015, and 2016.

Tours of the CDF Experiment:

- REU summer students, Aug. 5, 2009
- Fermilab Open House, Feb. 11 2007 and Jan. 17, 2009
- Linear Collider Accelerator School students October 24, 2008
- Hadron Collider Summer School students Aug 16, 2008
- Tour of CDF for local high school students May 21, 2008
- Private tour of Fermilab for small group of college students from Texas, March 19 2007
- Tour for Congressman Kirk and group of 7th graders, Feb. 17, 2007

Editor for “Result of the Week” in Fermi Today (2008 - 2010) : For two years I served as the editor for bi-weekly articles featuring new results from the CDF experiment in the online newsletter “Fermi Today”. I selected the topic and worked closely with the researchers and the editors of Fermi Today to ensure that the article was interesting and understandable to the non-scientists at Fermilab.

2008 Quadrennial Congress of Sigma Pi Sigma (Nov. 7,2008) :

- Volunteered for “breakfast with a scientist”
- Gave tour of the CDF experiment

Ask a Scientist: Available to answer questions from the public at Wilson Hall:

- May 6, 2007 , Nov. 2, 2008 , March 6, 2009 , Dec. 6, 2009 , and Feb. 21, 2010

Saturday Morning Physics: Tours of Fermilab facilities for local high school students:

- MIPP experiment on Jan. 23, 2010
- SciDet on Nov. 12, 2007 and Nov. 21, 2009
- DØ experiment on April 14, 2007 and Jan. 24, 2009
- Linear accelerator facilities Jan. 13, 2007

Workshop for Illinois Math and Science Academy: Tour of FNAL Linac, 15th floor, and LHC@FNAL for 80 math teachers, June 16, 2007

Science Fair Judge: Judged science projects of local middle school students, Naqua Valley High School, January 27, 2007